

REQUEST FOR RECONSIDERATION

Applicants thank Examiner Tsoy for the helpful and courteous discussion of June 5, 2003. During the discussion, Applicants' U.S. representative and German representative noted that the process claimed in the prior art reference cited by the Examiner favors curing in the presence of oxygen.

The Office rejected original Claims 1-9 and 11-17 as obvious in view of a patent to Howard (U.S. 4,133,723). Howard discloses coating compositions that comprise unsaturated urethane resins that are the reaction product of an organic isocyanate compound, a poly(alkylene oxide)polyol, and a polymerizable monomeric compound having an active hydrogen group that is co-polymerizable in the presence of a reactive diluent system with the unsaturated urethane resin (Claim 1).

Howard requires that the prior art urethane resin be derived from a poly(alkylene oxide)polyol (see Abstract; column 3, lines 3-11; column 3, lines 33-40; column 3, lines 41-49; column 4, line 21; and claim 1). The presence of a poly(alkylene oxide)polyol is disclosed to be an important aspect of the prior art invention, for example:

The present invention is based on the discovery that the nature of the polyol which is employed in forming energy-curable unsaturated urethane oligomers does materially affect the curing rate and air of such oligomers. More particularly, it has been discovered that the use of poly (alkylene oxide) polyols as precursor compounds for actinic radiation-curable unsaturated urethane oligomers affords compositions which can be cured in air at a rate which is commercially significantly more rapid than can be obtained with unsaturated urethane oligomers prepared from polyester polyol precursors. (Column 3, lines 4-14)

Each of the independent claims of Howard requires the presence of the poly(alkylene oxide)polyol and therefore the inclusion of a poly(alkylene oxide)polyol-derived urethane oligomer is an essential element of the prior art invention. Howard nowhere discloses that the prior art invention can be carried out with urethanes that are not derived from poly(alkylene oxide)polyols.

Present Claim 1 has been amended to require that the urethane prepolymer is obtained by reacting at least 25% of the isocyanate groups of an isocyanate-containing compound (A) with a hydroxy alkyl ester derivative of acrylic acid and/or methacrylic acid (B) and then subsequently reacting any remaining isocyanate groups with a compound that may be one of the compounds recited in the Markush group of Claim 1. Amended Claim 1 excludes the reaction of the isocyanate-containing compound with a poly(alkylene oxide)polyol and therefore excludes the urethane oligomers of Howard. Although Howard discloses that thiols such as dimercaptans and polymercaptans, or alkanolamines can be used as chain extending reagents in the prior art urethane, Howard does not disclose that these can be used to prepare urethane prepolymers that do not contain a poly(alkylene oxide)polyol derived urethane.

Amended Claim 1 excludes the invention compositions of Howard. Howard can therefore not anticipate or render obvious the subject matter of amended Claim 1. Applicants respectfully request the withdrawal of the rejections in view of the Howard reference.

Original Claim 6 (now canceled herein) further limited original independent Claim 1 by requiring that the urethane prepolymer is derived from an isocyanate group-containing compound reacted with hydroxy alkyl esters component (B) and another component reactive towards isocyanate groups (component (C)). The Office rejected Claim 6 on the grounds that Howard discloses the optional inclusion of a chain transfer reagent such as glycol mercapto acetate (page 3), paragraph 2 of the Office Action of May 15, 2003. It appears that the Office may have interpreted the subject matter of Claim 6 as allowing the inclusion of other reactive components such as poly(alkylene oxide)polyols.

Amended Claim 1 requires that no other components of the urethane prepolymer other than those specifically recited in the claim are present. The urethane prepolymer of amended Claim 1 is obtained by first reacting an isocyanate group-containing compound with a hydroxy alkyl ester derivative of an acrylic acid and/or methacrylic acid. Then, as stated in

the specification, "subsequently reacting the remaining isocyanate groups with a chain extender" (page 5, lines 32-33). Therefore the reaction of the isocyanate group containing component (A) with (B) and (C) utilizes all of the alcohol-reactive groups on the isocyanate group-containing component (A). After reaction of component (A) with components (B) and (C) further reaction with a poly(alkylene oxide)polyol at an isocyanatic functionality is not possible. Therefore, the poly(alkylene oxide)polyol-containing urethane oligomers of Howard are excluded from the presently claimed invention.

Applicants submit the subject matter of amended Claim 1 is novel and not obvious in view of Howard and respectfully request the withdrawal of the rejection.

Claim 18 is a new dependent claim. Dependent Claim 18 limits the diluent of amended Claim 1 to those materials which comprise at least one esterified polyol having 5 or more acrylate groups.

The reactive diluent systems of Howard are disclosed at column 7, line 21 through column 8, line 9. Particularly preferred reactive diluents are presented at column 7, lines 40-50 and appear to be monofunctional monomeric compounds. Polyfunctional monomeric diluents are also disclosed at column 7, lines 64-68. Pentaerythritol di-, tri-, or tetra-acrylate is disclosed at lines 66-67. Nowhere is a reactive diluent having five or more acrylate groups disclosed.

The performance of coatings obtained by curing the prior art compositions is disclosed in the Examples of Howard of Table III in column 13. In the legend text for Table III, it is disclosed that gloss retention after scrubbing is poorer when the composition is cured in oxygen in comparison to nitrogen. Applicants note, however, that none of the resin formulations described in the Examples of Howard contain a reactive diluent having more than three acrylate groups (see, for example, pentaerythritol triacrylate as the third component of the formulations of Table II).

Howard is silent with respect to reactive diluents containing five or more acrylate groups. Applicants respectfully submit that the method of new Claim 18, is not anticipated by or obvious in view of the disclosure of the Howard patent. The presently claimed invention is further unobvious in view of the Howard patent since the presently claimed invention requires curing in an inert atmosphere whereas Howard discloses that the prior art resin may be cured in the presence of oxygen or nitrogen.

Applicants have compared the performance of coatings obtained from compositions that include a penta/hexaacrylate with coatings obtained from compositions that contain mono- and/or tri-acrylate diluents.

Table 2a on page 14 of the specification provides the scratch resistance and other mechanical performance characteristics of coatings obtained by curing aliphatic urethane acrylate prepolymer mixtures in the absence of oxygen. As is immediately evident from a quick comparison of the results of Table 2a, performance characteristics, such as scratch resistance, pendulum hardness, and Erichsen indentation are significantly better for the reactive diluent containing 5 or more acrylate groups in comparison with the examples that use other reactive diluents. Table 1 below provides the compositional data for each composition in Table 2a.

Table 2a: Test results of coatings 1 to 11 on curing under a nitrogen atmosphere ($O_2 \leq 500$ ppm, determined by means of a Galvanoflux probe - electrochemical cell based on a lead/lead oxide redox couple)

Example	Scratch resistance ¹⁾ (Δ gloss value)		Pendulum attenuation ²⁾	Erichsen indentation ³⁾
	10 DS	50 DS	(s)	(mm)
	4.5	6.1	172	3.5
2	3.3	6.3	176	0.7
3	5.4	9.1	189	0.9
4	3.9	6.0	189	0.9
5	3.1	5.1	181	0.9
6	2.7	4.3	175	0.8
7	2.2	3.7	183	0.6
8	0.6	1.3	182	0.5
9	3.7	5.5	178	2.3
10	2.7	6.0	172	1.2
11	2.0	5.1	185	0.8

Boxed row indicates presence of diluent with five or more acrylate groups.

Compare to Examples 4 and 10 which also have a 50:50 split of diluents

Table 1: Composition of coating compositions 1-11

Coating Composition	LR 8987 (1)	THEIC (2)	PHA (3)	HDDA (4)	Irgacure 184 (5)
1	100				4
2	90	10			4
3	70	30			4
4	50	50			4
5	95		5		4
6	90		10		4
7	80		20		4
8	50		50		4
9	80			20	4
10	50			50	4
11	20			80	4

- (1) Laromer® LR 8987: commercial mixture of an aliphatic urethane acrylate containing 30% by weight hexanediol diacrylate, from BASF AG.
 Molecular weight approximately 650 g/mol,
 Functionality approximately 2.8 double bonds/mol (about 4.5 mol/kg),
 Viscosity 2-6 Pa.s (DIN EN ISO 3219).
- (2) THEIC: triacrylate of tri(hydroxyethyl)cyanurate
- (3) PHA: dipentaerythritol penta/hexaacrylate
- (4) HDDA: hexanediol diacrylate
- (5) Irgacure® 184 from Ciba Geigy, commercial photoinitiator.

As is evident from the compositional data of Table 1, the Examples may contain various polyfunctional diluent species such as hexane diol diacrylate (HDDA - column 5 of Table 1), dipentaerythritol penta/hexaacrylate (PHA - column 4 of Table 1), and triacrylate of tri(hydroxyethyl)cyanurate (THEIC - column 3 of Table 1).

Examples 5-8 contain a diluent that has five or more acrylate groups. When one compares the scratch resistance of coatings prepared from compositions that contain a diluent having at least five acrylate groups, it is immediately evident that these coatings provide superior scratch resistance in comparison to coatings prepared with a triacrylate of tri(hydroxyethyl)cyanurate and/or hexanediol acrylate. For example, one may compare Examples 2 and 6. In both of these Examples, the coating composition contains 10% of the reactive diluent, THEIC or PHA, respectively. The scratch resistance is significantly better for the coating obtained from the claimed composition as can be seen by the change in gloss value after both 10 and 50 strokes (compare 3.3 vs. 2.7; and 6.3 vs. 4.3, for 10 and 50 strokes respectively). A similar improvement is observed when comparing Examples 7 and 9 wherein PHA and HDDA are present in an amount of 20 wt%. The superiority of the PHA-containing composition is demonstrated in the scratch resistance which is 2.2 vs. 3.7; and 3.7 vs. 5.5 for 10 and 50 strokes respectively in favor of the claimed composition. It is also evident that the best scratch resistance and Erichsen indentation performance of all of the examples is exhibited by Example 8 which contains 50% by weight of dipentaerythritol penta/hexaacrylate and may be compared to Examples 4 and 10 which also have a 50:50 slit of reactive diluent.

Applicants have therefore demonstrated that the physical properties of coatings that are prepared from compositions that contain an aliphatic urethane (meth)acrylate prepolymer and a diluent having five or more acrylate groups, can provide superior scratch resistance

performance. Therefore the subject of matter of at least new Claim 18 is patentable over Howard.

Applicants submit the amendment to the claims places all now-pending claims in condition for allowance. Applicants respectfully request the withdrawal of the rejections and the passage of all now-pending claims to Issue.

Respectfully submitted,

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